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2018-04-18

Design and Evaluation of an Acoustic Homing System Integrating NAVY Relevant Research into Robotics Classroom

Dobrokhodov, Vlad; Leary, Paul

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Design and Evaluation of an Acoustic Homing System: Integrating NAVY Relevant Research into Robotics Classroom

Dr. Vlad Dobrokhodov, MAE

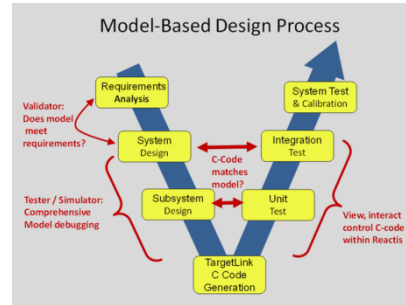
Dr. Paul Leary, Physics

Objective - connect unique naval experience with the academic knowledge acquired at NPS.

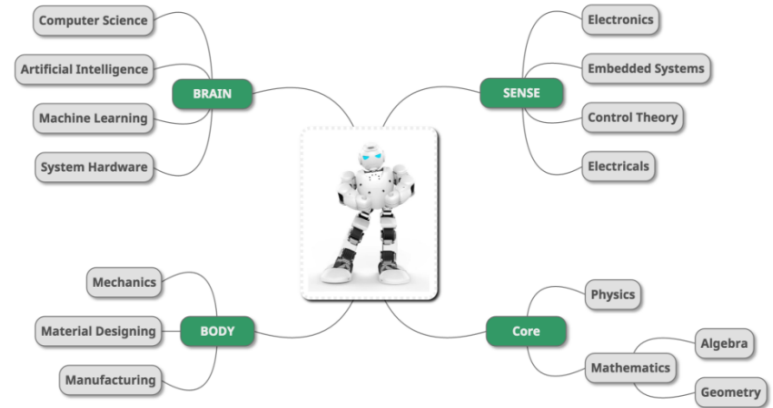
Approach – Model-Based Design method that connects fundamental properties of sensing, DSP, and GNC design with mission objectives.

Tools and methods – math. simulation, embedded coding, acoustic experimentation.

Focus area - sound localization and acoustics-driven wheeled robot as a prototype of a homing torpedo.

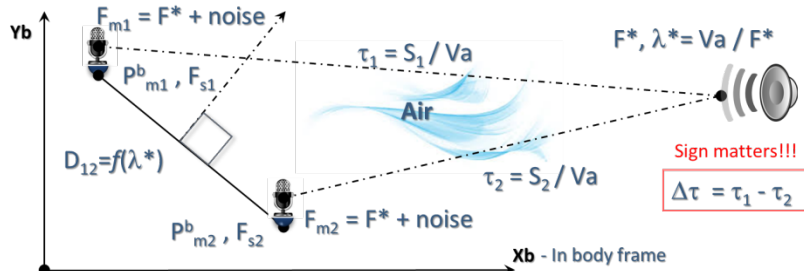


Challenges of Robotics – confluence of diverse set of interconnected fundamental disciplines



<http://www.janeve.me/featured/how-to-get-started-in-robotics>

Sound Localization in 2D



Fundamental concepts:

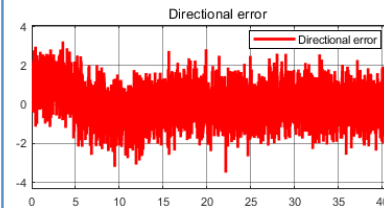
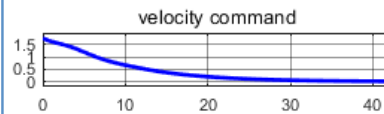
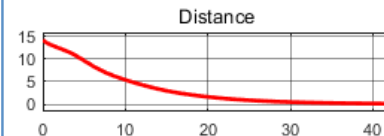
Spatial separation

- HDOP
- Multiple sensors
- Geometry of the array
- Dependent measurements

Temporal separation

- Nyquist frequency
- Concurrent sampling
- Noise in measurements
- Resolution & detectability

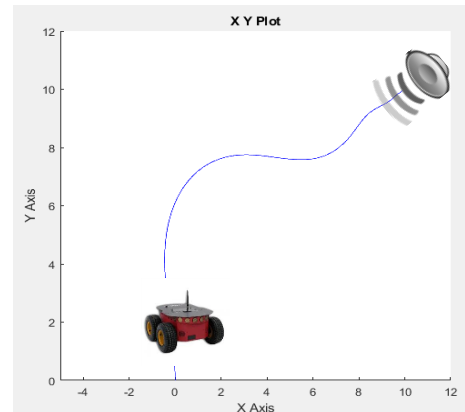
Homing Guidance & Control in 2D – first studied in Simulink



$$G_c(s) = K_p + \frac{K_i}{s} + K_d s$$

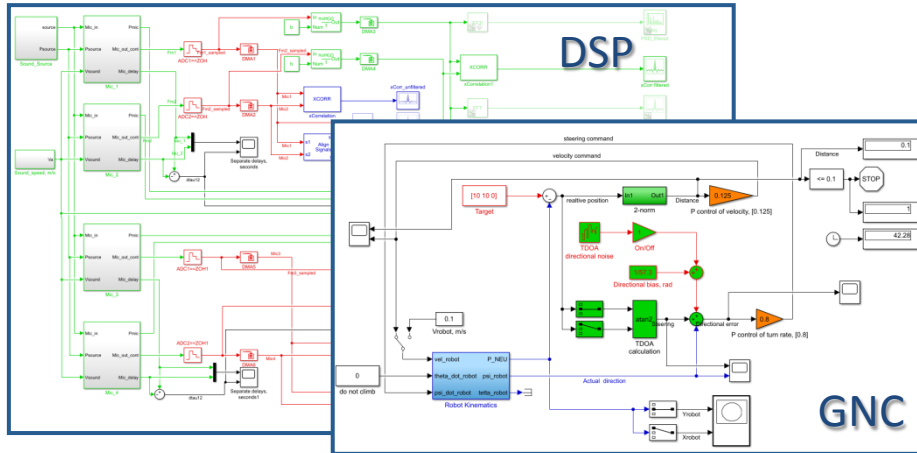
$$u(t) = K_p e(t) + K_i \int e(t) dt + K_d \frac{de(t)}{dt}$$

Action = Current + Past + Future

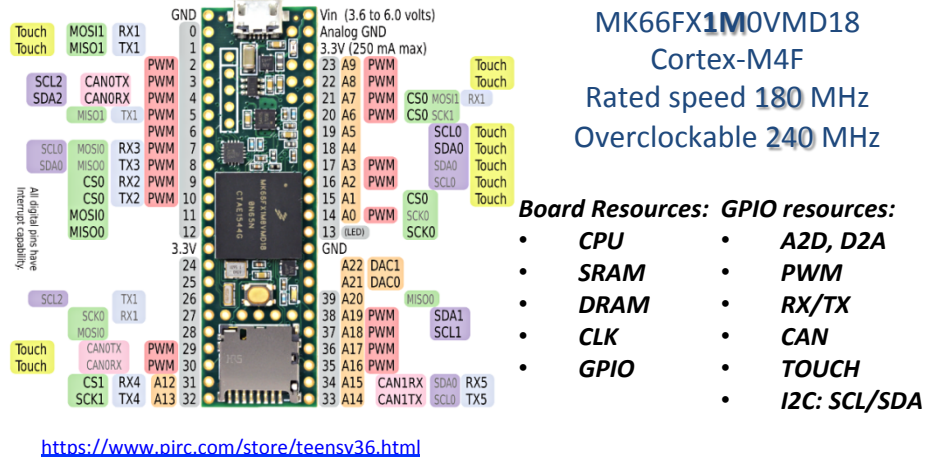


Key Components of Robotics Classroom

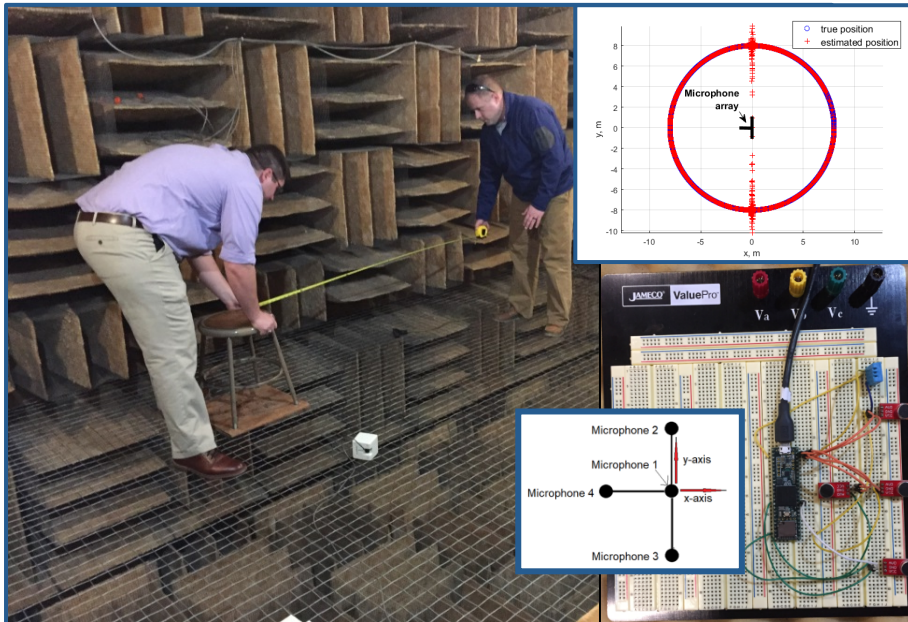
M&S of acoustics and GNC – “align fundamental principals” and perform initial V&V



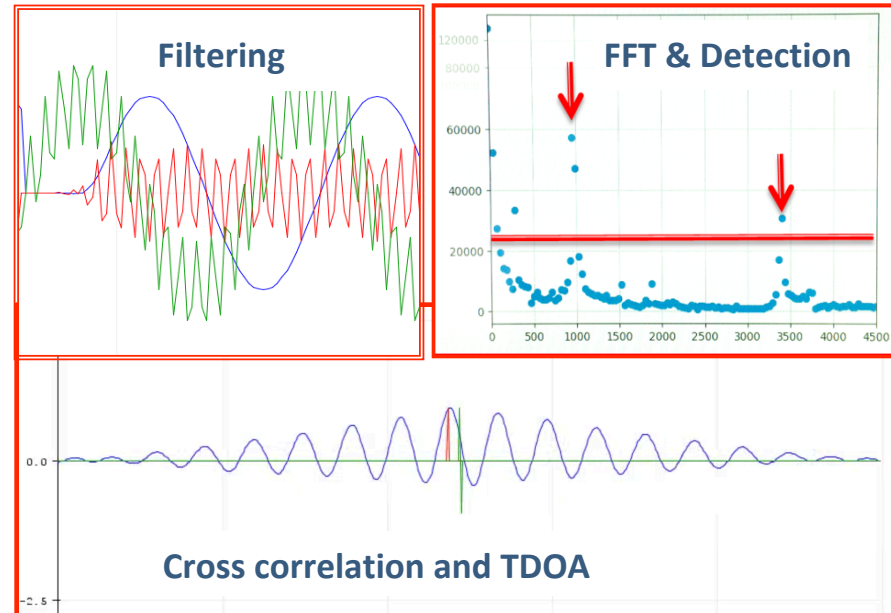
Embedded coding – learn optimal resource allocation within single DSP board using modern C/C++.



Design and Experimentation – anechoic room

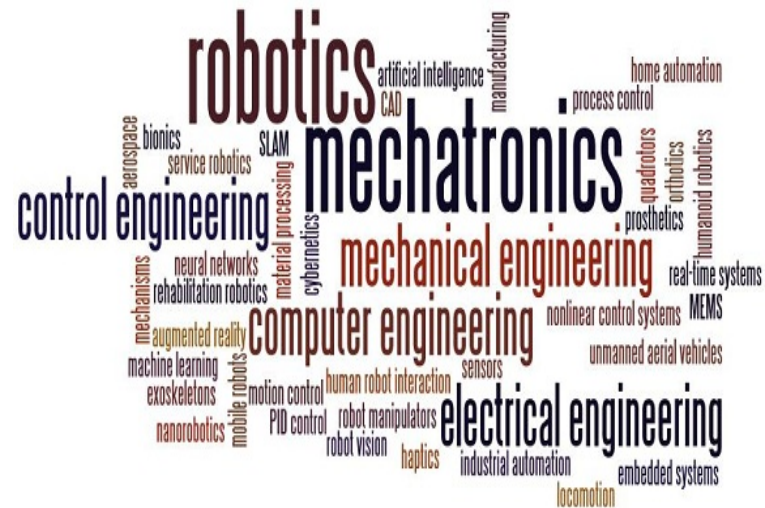


Validation and Verification



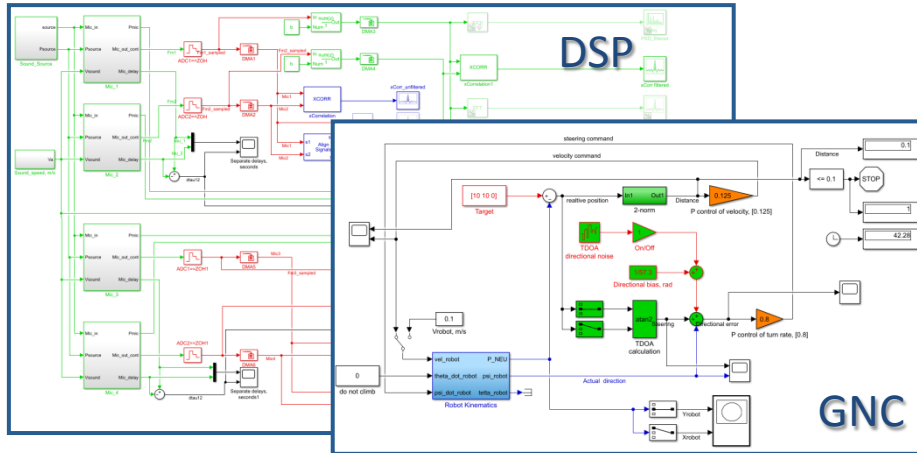
Conclusion

- Robotics requires expertise in a number of fields
- Each particular field has “infinite depth”
- Integration of subfields must be systematic to achieve the desired verifiable result
- Keystones of robotics:
 - Physics
 - Mathematics
 - Computer science
 - ...
 - and nearly everything else that you might think of

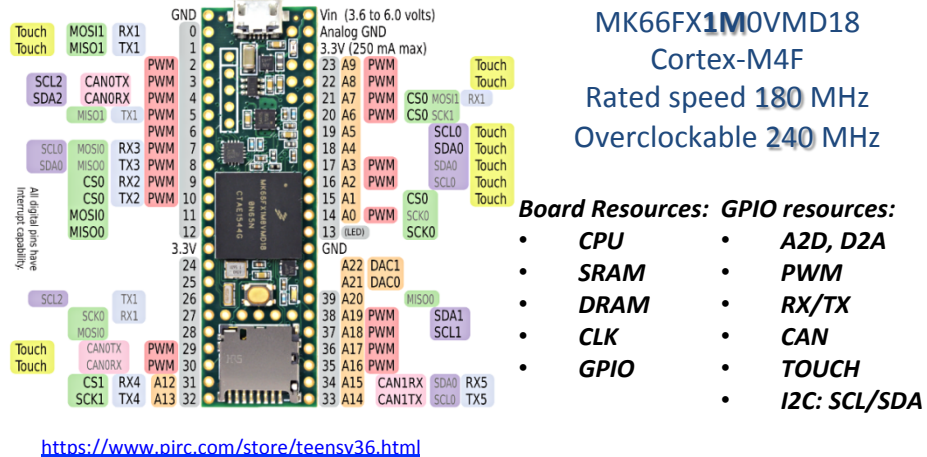


Key Components of Robotics Classroom

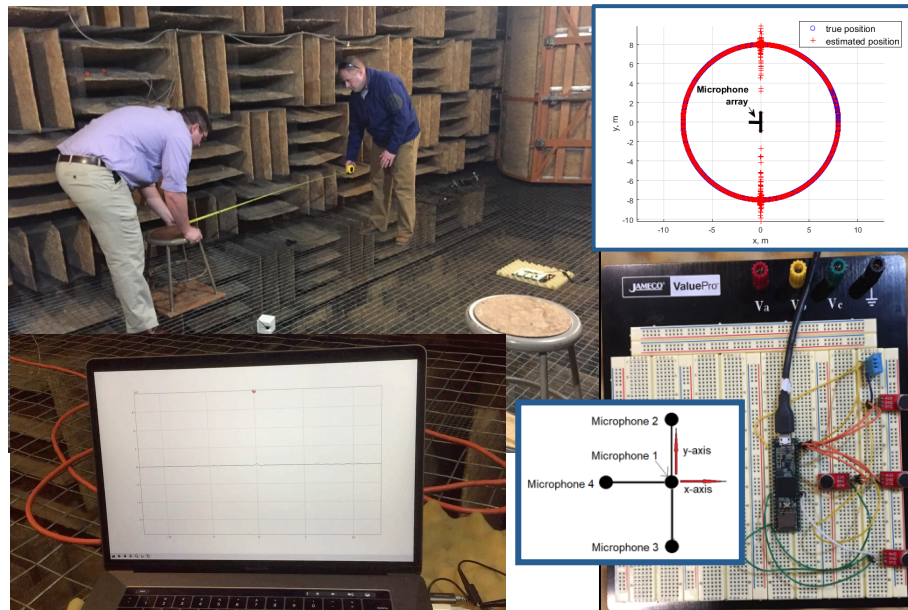
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